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File: USPT

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DOCUMENT-IDENTIFIER: US 6491764 B2

TITLE: Method and apparatus for removing a liquid from a surface of a rotating substrate

Brief Summary Text (13):

The liquid is selected dependent upon the applied wet processing step like e.g. a wet etching step or a cleaning step or a rinsing step. To initiate the drying process, besides said liquid also a gaseous substance reducing the surface tension of said liquid is sprayed on at least one surface of said substrate. Particularly, a pressurized gaseous substance is actively supplied e.g. by using at least one nozzle, said nozzle preferably being movable. Alternatively, instead of a movable nozzle, at least one static inlet can be used for supplying, preferably actively, said gaseous substance on said surface of said substrate. Said surface tension reducing gaseous substance can be isopropyl alcohol (IPA), but also any other gaseous substance which is miscible with said liquid and which will form a mixture with said liquid having a surface tension lower than that of said liquid alone, can be used. Particularly, said gaseous substance may be heated at a temperature typically in the range between 20 and 100 degrees Celsius.

Brief Summary Text (14):

In another embodiment of the invention, eventually prior to the liquid removal step an etching, a cleaning or a rinsing liquid or a sequence of such liquids can be supplied to the entire surface of a rotating substrate. Particularly prior to the liquid removal step of the present invention, a liquid comprising water, ozone and an additive acting as a scavenger can be dispensed on a surface of a rotating substrate in order to remove organic contaminants from said surface. Preferably said liquid is maintained at a temperature below the boiling point of said liquid. The parameters can be optimized such that a liquid film can completely cover a surface. The spinning motion will quickly transport the liquid over the surface towards the edge, thus allowing relatively short carry-over transients and thus also allowing for relatively short rinsing times. Using such a continuously switched flow of liquids eliminates the undesirable passage of liquid-gas interfaces over the surface. The liquid removal method of the present invention is applicable for each sequence of at least one wet processing step by supplying a surface tension reducing gaseous substance together with the liquid. The drying can thus be applied directly on the processing liquid if relevant for the application. Since the proposed drying technique is found to be very fast, process non-uniformity over the surface can be kept very low.

Detailed Description Text (3):

In an aspect of the invention a method of removing a liquid from at least one surface of at least one substrate is disclosed, said method comprising the steps of: supplying a liquid on at least a part of said surface of said substrate; supplying a gaseous substance to said surface of said substrate, said gaseous substance being at least partially miscible with said liquid and when mixed with said liquid yielding a mixture having a surface tension being lower than that of said liquid; and subjecting said substrate to a rotary movement. Said gaseous substance can comprise a vaporised substance which is miscible with said liquid and when mixed with said liquid yields a mixture having a surface tension being lower than that of said liquid. A vaporised substance is defined as a mist of finely

dispersed liquid droplets of an element or a compound or a mixture of elements or as a vapor. A vapor is defined as the gas phase occurrence of an element or of a compound or of a mixture of elements if the element or compound or mixture should be in the liquid or solid phase at the given temperature and pressure conditions. Thus a vapour can co-exist in one environment with the solid or liquid phase of the element. A vapour is a specific gas phase occurrence of an element or a compound or a mixture of elements. Said gaseous substance can comprise a gas which is miscible with said liquid and when mixed with said liquid yields a mixture having a surface tension being lower than that of said liquid. Said gaseous substance can comprise a mixture of a vaporised substance and a gas, particularly an inert gas like e.g. helium, argon or nitrogen, said mixture being at least partially miscible with said liquid and when mixed with said liquid yielding a mixture having a surface tension being lower than that of said liquid. Particularly, by supplying said liquid and said gaseous substance on said surface of said substrate, at least locally a sharply defined liquid-vapor boundary is created. Said boundary has to be such that, at least within the part of the surface which is not rewetted during a subsequent revolution, said boundary is a continuous one, i.e. said part is determined by the lateral movement of said boundary during a revolution. According to the method of the present invention, said rotary movement is performed at a speed to guide said liquid-vapor boundary over said substrate. The configuration is such that the liquid is kept at the liquid side of the liquid-vapor boundary.

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